Linking Watershed Management and Ocean Management with Internet-based Mapping Tools

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California's long and diverse coastline is the ocean edge of even larger and more diverse watersheds that drain to the ocean through numerous waterways. There is increasing agreement that land and water use within the watershed, essentially watershed management of the planned and unplanned varieties, has a major role in determining water quality in the waterways and along the coastline. Translating this general agreement into a broadly agreed upon description of the problems, possible interventions, and probable effectiveness often founders on three problems: the conflicting watershed 'world views' of different departments, misapplication of reasonable solutions to the wrong places, and the difficulty of integrating the stochastic nature of hydrologically driven processes that drain landscapes into rule based regulations. Given that the effectiveness of watershed management for protecting ocean water quality is proportional to how well the interventions are matched to underlying conditions, there is a need for more intuitive and informative tools to identify conditions and the reasonable hypotheses about watershed resource use and downstream water quality interactions.

Currently, topographical maps as well as maps of watershed boundaries for larger watersheds are available to all agencies and most interested stakeholders. However, it is often difficult to get accurate summaries of land use, land ownership, and detailed topological and hydrological information for smaller watersheds where the impact of a specific project would be most noticeable. While it is common for significant projects to undertake site-specific assessments, there is no commonly available set of baseline data available to all parties. Some of the most diverse situations are the smaller watersheds that drain directly to the ocean and major bays. In many cases, there is a lack of locally accurate information and a tendency to use larger or more well known examples as the basis for a rapid analysis of the situation and any restoration or improvement plan. In many cases the use of inaccurate assessments can lead to contentious disagreements among various stakeholders who are often working from very different views of the situation.

The broader use of common information systems that are spatially accurate, stocked with current information, and equipped with interfaces that convey information to the end users could substantially improve the overall effectiveness of governmental and non-governmental approaches to improve watershed management for the benefit of instream and ocean water quality. The Fire and Resource Assessment Program (FRAP) of the California Department of Forestry and Fire Protection is responsible

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for assessing wildland resources across the whole state, including the coastline. The Coastal Watershed Mapping Tool posted on FRAP's web site at www.frap.cdf.ca.gov was developed to provide and integrated tool for any user to access key land use data for any of the 347 watersheds that drain directly to the ocean or a major bay.

The Coastal Watershed Mapping Tool is based on the CalWater planning watersheds (Version 2.2). These are the smallest watersheds mapped in CalWater and cover nearly 4.4 million acres -- nearly 5 percent of the total land area of the state. The average size of these watersheds is around 20 square miles, with smaller watersheds in the more mountainous regions and larger watersheds in the lower gradient areas that are also more urbanized.

Table 1. Variations in size of coastal watersheds by hydrologic regions

Hydrologic Regions	Acres	Number of Watersheds	Avg. Size of Watersheds
North Coast	640,471	94	6,816
SF Bay Area	1,250,070	67	18,665
Central Coast	1,053,577	98	10,755
South Coast	1,420,059	88	16,713
Total	4,364,177	347	12,577

In addition to the variation in the physical characteristics of the watersheds (average size, terrain, rainfall), land use varies substantially between the regions. The following table illustrates the large differences among regions in terms of the mix of land uses in coastal watersheds. Each of the four hydrologic regions has a unique pattern. The North Coast region has only limited amounts of urban and irrigated agriculture land uses and is dominated by forestlands and ranchlands, which are often referred to as working landscapes. Working landscapes typically have more roads, road usage, and vegetation management activities than reserve lands but are far less intensively managed than urban or irrigated agricultural lands. The other regions have considerably more area with urban and agricultural land uses that typically produce more altered runoff into streams and the ocean.

Table 2. Variation in major land uses by hydrologic regions

Regions	Urban	Agriculture	Working	Reserves
North Coast	5%	7%	72%	17%
SF Bay Area	40%	5%	38%	17%
Central Coast	12%	16%	51%	21%
South Coast	56%	5%	24%	14%
Total	33%	8%	42%	17%

While the exact levels of potential pollutants associated with runoff varies tremendously across watersheds, a reasonable first-order estimate can be derived

from the number of acres of different land uses and the types of ownership. The following table illustrates some of the major non-point source pollutants that can are often related to different types of land uses.

Table 3. Probable pollutants related to major land uses

Urban - Residential, Commercial, Transportation corridors	Irrigated Agriculture	Working Landscapes – forests and rangelands	Reserves and Parks
Transport-related oil residues	Fertilizers	Sediment	Consumer garbage
Peak water flows	Herbicides	Woody debris	Sediment
Consumer garbage	Pesticides	Herbicides	Woody debris
Fertilizers	Salts	Animal waste	Peak water flows
Herbicides	Animal waste	Peak water flows	
Pesticides	Bacteria	Fertilizers	
Industrial chemicals	Sediment		
Animal waste			
Bacteria			

The Coastal Watershed Mapping Tool allows anyone to locate a watershed of interest by zooming into a statewide map and using watershed boundaries and scanned U.S. Geological Survey quad maps. These maps illustrate key hydrographic components such as streams and watershed boundaries as well as major roads, urbanized areas, and coarse vegetation condition. After an individual watershed is chosen, the linked screens provides information on endangered salmonid habitat, average rainfall, as well as detailed acreage summaries of the most recent statewide coverage of land use and vegetation cover and public land ownership categories. Statewide coverages for these layers and other information sets are also available on the FRAP web site but they require greater computational capabilities to access. The advantage of this mapping tool is that it allows anyone with access to the internet to retrieve detailed information on factors that play a major role in determining potential non-point source pollution sources and key parameters affecting wildlife habitats.

The following example illustrates the significant differences in ownership and land cover for six adjacent watersheds starting in downtown Santa Barbara and continuing twenty miles along the coast. The significant variation between these adjacent watersheds implies that the most effective interventions will vary substantially and should be tailored to match local conditions. The greatest variation among the watersheds is in the percentage of land with agriculture and urban land covers. These two land covers have very different types of water quality and increased peak water flows compared to naturally vegetated areas. The different types of natural vegetation will typically produce fewer additions to the natural flow regime but will have significantly different patterns of runoff after large fires.

Table 4. Land cover for six watersheds south of the city of Santa Barbara

	Sycamore Canyon	San Ysidro Canyon	Romero Canyon	Carpenteria Creek	Rincon Creek	Madriano Canyon
Ownership						
Private	100%	75%	69%	95%	41%	4%
State	0%	0%	0%	5%	0%	0%
Federal	0%	25%	31%	0%	59%	96%
Land Cover						
Agriculture	1%	1%	14%	48%	22%	18%
Grassland	0%	1%	3%	2%	1%	5%
Barren	0%	0%	0%	1%	1%	0%
Chamise Chaparral	0%	0%	0%	0%	0%	0%
Woodland	4%	4%	13%	1%	8%	14%
Scrub	2%	0%	1%	1%	4%	30%
Mixed Chaparral	15%	54%	31%	0%	61%	23%
Montane Hardwood	0%	0%	0%	0%	0%	0%
Montane Riparian	0%	4%	1%	4%	2%	0%
Wetland	0%	0%	0%	4%	0%	0%
Water	1%	0%	0%	0%	1%	0%
Urban	71%	36%	30%	44%	1%	9%

Conclusions

The variability of the character of coastal watersheds is great and has a direct influence on downstream stream and ocean water quality. The physical effectiveness and cost effectiveness of various interventions such as restoration projects, accelerating the use of best management practices, or prohibiting certain land uses will depend directly on how well matched they are to local watershed conditions. The Coastal Watershed Mapping Tool posted on FRAP's web site at www.frap.cdf.ca.gov was developed to provide and integrated tool for any user to access key land use data for any of the 347 watersheds that drain directly to the ocean or a major bay. Increasing the availability of watershed-specific data on land use, land cover, and other key physical parameters should increase the effectiveness of targeting actions appropriate to specific watersheds. It can also be an effective data source for testing assumed relationships between land use and the condition of ocean-draining streams up and down the coast of California.